incomplete mixing. The average isotopic ratios (and their ranges) of the lake sediments (9 samples) and of the Hudson Bay sediments (8 samples) are as follows:

| | Lake Sediments | Hudson Bay Sediments |
|---|---|---|
| $Pb^{206}/Pb^{204}$ | 22.54 (20.09–26.81) | 23.31 (21.63–25.00) |
| $Pb^{206}/Pb^{207}$ | 1.392 (1.258–1.623) | 1.435 (1.352–1.523) |
| $Pb^{206}/Pb^{208}$ | 0.511 (0.474–0.550) | 0.518 (0.499–0.534) |

A two-stage model has been constructed to fit the evolution of the Canadian shield leads by assuming the following parameters: (1) the mean differentiation age of the shield was $2 \times 10^9$ years; (2) the $U^{238}/Pb^{204}$ value was enriched from 8.7 to 14-30; and (3) the $Th^{232}/U^{238}$ value remained constant at about 3.9. The leads in these three lakes are discharging into the Arctic Ocean through the MacKenzie River and may account for the relatively radiogenic lead in the Beaufort Sea sediments.

(V11) R. D. Russell and P. H. Reynolds (Dept. of Geophysics, University of British Columbia, Vancouver, Canada), *The Primary Lead Growth Curve and the Age of the Earth.* This study was initiated in an attempt to discriminate between the two values of $t_0$ commonly used in lead isotope studies, namely 4500 m.y. and 4550 m.y. It is assumed that there exists a primary lead isotope ($Pb^{207}/Pb^{204}$ versus $Pb^{206}/Pb^{204}$) growth curve, and that it corresponds mathematically to growth in a single closed system. Because even the most carefully selected samples may be anomalous (i.e., they may have been the product of multiple growth stages), it seems unwise to use age relationships in determining the growth curve. If the anomalies are slight, the measured points will still lie close to the primary curve even though their apparent ages may be in substantial error. Therefore we have determined a primary growth curve by fitting the growth equations to selected common lead samples without using age data. The sensitivity of the procedure to anomalous leads was tested by deliberately inserting suites of such leads from Sudbury and Broken Hill. The time scale along the growth curve is uniquely determined by its shape. This makes an independent determination of the isotopic abundances of 'modern' lead possible with an accuracy of 1/2 per cent or better. A value for the age of the Earth can also be obtained if the corresponding point on the growth curve is known. A range of values was obtained from the theoretical $Pb^{207}/Pb^{206}$ primeval ratio of D. D. Clayton. A particular value can be obtained from the primeval $Pb^{207}/Pb^{206}$ ratio determined by R. Murthy and C. C. Patterson from troilite abundances. Results in the range 4520–4560 m.y. have been obtained this way, the higher values being preferred. This supports Patterson's value of 4550 m.y. rather than Houtermans' value of 4500 m.y.

(V12) G. J. Wasserburg (California Institute of Technology, Pasadena), *Pb-U-Th Evolution Models for Homogeneous Systems with Transport.* Various authors have discussed the evolution of lead for different models of crust mantle differentiation. The equations which have been used have an implicit assumption which can cause them to be in serious error, particularly in the case of significant transport of lead from systems with different isotopic composition. The general equations of transfer for a single Pb-U-Th system may be written

$$d\alpha/d\tau = \lambda_{U^{238}}\mu + (\alpha^* - \alpha)J/N$$

where $\alpha$ and $\mu$ are the ratio of $Pb^{206}/Pb^{204}$ and $U^{238}/Pb^{204}$ for the system, $\alpha^*$ is the isotopic composition of the lead which is being added to the system, and $J/N$ is the flow of $Pb^{204}$ into the system divided by the number of $Pb^{204}$ atoms in the system. Similar equations hold for $\beta$ and $\gamma$. Previous treatments have assumed that

$$(\alpha^* - \alpha)/(\beta^* - \beta) = (\lambda_{U^{238}}/\lambda_{U^{235}})\cdot(U^{238}/U^{235})$$

For the general case of transfer between $K$ homogeneous systems, the equations are, for system $m$,

$$\frac{dN^m{}_{Pb^{204}}}{d\tau} = \sum_{n=1}^{K} N^n{}_{Pb^{204}} G^n X_{nm}$$

$$\frac{dN^m{}_{Pb^{206}}}{d\tau} = \lambda_{U^{238}} N^m{}_{U^{238}} + \sum_{n=1}^{K} N^n{}_{Pb^{206}} G^n X_{nm} \cdots$$

and

$$\frac{dN^m{}_{U^{238}}}{d\tau} = -\lambda_{U^{238}} N^m{}_{U^{238}} + \sum_{n=1}^{K} N^n{}_{U^{238}} H^n Y_{nm}$$

$$\Big( Y_{ii} = X_{ii} = -1$$

and

$$\sum_{m=1}^{K} X_{nm} = \sum_{m=1}^{K} Y_{nm} = 0 \Big)$$

Here $G^n$ ($\tau$) and $X_{nm}$ ($\tau$) are the loss functions and transfer coefficients respectively for Pb. $H^n$ and $Y_{nm}$ are for U. It may be shown that these terms are related to the fractionation factors for Pb and U between the systems. Calculations of some two-layer crust-mantle evolution models will be presented and the general nature of isochrons will be discussed.